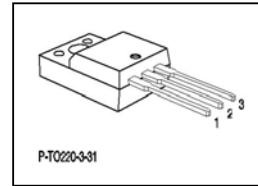


CoolMOS™ Power Transistor
Product Summary
Features

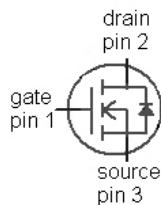
- New revolutionary high voltage technology
- Intrinsic fast-recovery body diode
- Extremely low reverse recovery charge
- Ultra low gate charge
- Extreme dv/dt rated
- High peak current capability
- Periodic avalanche rated
- Qualified according to JEDEC⁰⁾ for target applications

| | | |
|------------------|------|----------|
| V_{DS} | 600 | V |
| $R_{DS(on),max}$ | 0.44 | Ω |
| $I_D^{1)}$ | 11 | A |

PG-T0220-3-31



| Type | Package | Ordering Code | Marking |
|-------------|-------------|---------------|----------|
| SPA11N60CFD | TO-220-3-31 | SP000216317 | 11N60CFD |


Maximum ratings, at $T_j=25$ °C, unless otherwise specified

| Parameter | Symbol | Conditions | Value | Unit |
|--|----------------|--|-------------|------|
| Continuous drain current ¹⁾ | I_D | $T_C=25$ °C | 11 | A |
| | | $T_C=100$ °C | 7 | |
| Pulsed drain current ²⁾ | $I_{D,pulse}$ | $T_C=25$ °C | 28 | |
| Avalanche energy, single pulse | E_{AS} | $I_D=5.5$ A, $V_{DD}=50$ V | 340 | mJ |
| Avalanche energy, repetitive ^{2),3)} | E_{AR} | $I_D=11$ A, $V_{DD}=50$ V | 0.6 | |
| Avalanche current, repetitive ^{2),3)} | I_{AR} | | 11 | A |
| Drain source voltage slope | dv/dt | $I_D=11$ A, $V_{DS}=480$ V, $T_j=125$ °C | 80 | V/ns |
| Reverse diode dv/dt | dv/dt | $I_S=11$ A, $V_{DS}=480$ V, $T_j=125$ °C | 40 | V/ns |
| Maximum diode commutation speed | di/dt | | 600 | A/μs |
| Gate source voltage | V_{GS} | static | ±20 | V |
| | | AC ($f>1$ Hz) | ±30 | |
| Power dissipation | P_{tot} | $T_C=25$ °C | 33 | W |
| Operating and storage temperature | T_j, T_{stg} | | -55 ... 150 | °C |

| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------|--------|------------|--------|------|------|------|
| | | | min. | typ. | max. | |

Thermal characteristics

| | | | | | | |
|--|------------|---------------------------------------|---|---|-----|-----|
| Thermal resistance, junction - case | R_{thJC} | | - | - | 3.8 | K/W |
| Thermal resistance, junction - ambient | R_{thJA} | leaded | - | - | 62 | |
| Soldering temperature, wave soldering | T_{sold} | 1.6 mm (0.063 in.) from case for 10 s | - | - | 260 | °C |

Electrical characteristics, at $T_j=25$ °C, unless otherwise specified

Static characteristics

| | | | | | | |
|----------------------------------|---------------|--|-----|------|------|----|
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}=0$ V, $I_D=250$ µA | 600 | - | - | V |
| Avalanche breakdown voltage | $V_{(BR)DS}$ | $V_{GS}=0$ V, $I_D=11$ A | - | 700 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS}=V_{GS}$, $I_D=1.9$ mA | 3 | 4 | 5 | |
| Zero gate voltage drain current | I_{DSS} | $V_{DS}=600$ V, $V_{GS}=0$ V, $T_j=25$ °C | - | 1.1 | - | µA |
| | | $V_{DS}=600$ V, $V_{GS}=0$ V, $T_j=150$ °C | - | 900 | - | |
| Gate-source leakage current | I_{GSS} | $V_{GS}=20$ V, $V_{DS}=0$ V | - | - | 100 | nA |
| Drain-source on-state resistance | $R_{DS(on)}$ | $V_{GS}=10$ V, $I_D=7$ A, $T_j=25$ °C | - | 0.38 | 0.44 | Ω |
| | | $V_{GS}=10$ V, $I_D=7$ A, $T_j=150$ °C | - | 1.02 | - | |
| Gate resistance | R_G | $f=1$ MHz, open drain | - | 0.86 | - | |
| Transconductance | g_{fs} | $ V_{DS} >2 I_D R_{DS(on)max}$, $I_D=7$ A | - | 8.3 | - | s |

| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------|--------|------------|--------|------|------|------|
| | | | min. | typ. | max. | |

Dynamic characteristics

| | | | | | | |
|--|--------------|---|---|------|---|----|
| Input capacitance | C_{iss} | $V_{GS}=0$ V, $V_{DS}=25$ V, $f=1$ MHz | - | 1200 | - | pF |
| Output capacitance | C_{oss} | | - | 390 | - | |
| Reverse transfer capacitance | C_{rss} | | - | 30 | - | |
| Effective output capacitance, energy related ⁴⁾ | $C_{o(er)}$ | $V_{GS}=0$ V, $V_{DS}=0$ V to 480 V | - | 45 | - | |
| Effective output capacitance, time related ⁵⁾ | $C_{o(tr)}$ | | - | 85 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}=480$ V, $V_{GS}=10$ V, $I_D=11$ A, $R_G=6.8$ Ω | - | 34 | - | ns |
| Rise time | t_r | | - | 18 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 43 | - | |
| Fall time | t_f | | - | 7 | - | |

Gate Charge Characteristics

| | | | | | | |
|-----------------------|---------------|---|---|-----|----|----|
| Gate to source charge | Q_{gs} | $V_{DD}=480$ V, $I_D=11$ A, $V_{GS}=0$ to 10 V | - | 9 | - | nC |
| Gate to drain charge | Q_{gd} | | - | 23 | - | |
| Gate charge total | Q_g | | - | 48 | 64 | |
| Gate plateau voltage | $V_{plateau}$ | | - | 7.5 | - | |

⁰⁾ J-STD20 and JESD22

¹⁾ Limited only by maximum temperature.

²⁾ Pulse width t_p limited by $T_{j,max}$
³⁾ Repetitive avalanche causes additional power losses that can be calculated as $P_{AV}=E_{AR} \cdot f$.

⁴⁾ $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

⁵⁾ $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

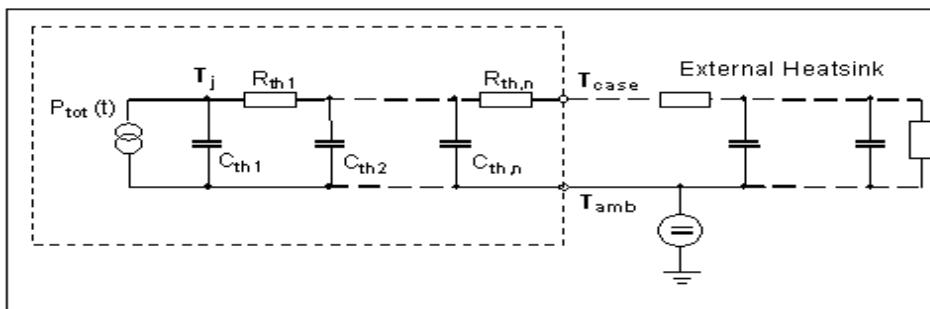
| Parameter | Symbol | Conditions | Values | | | Unit |
|-----------|--------|------------|--------|------|------|------|
| | | | min. | typ. | max. | |

Reverse Diode

| | | | | | | |
|--|---------------|---|---|-----|-----|---------------|
| Diode continuous forward current ¹⁾ | I_S | $T_C=25\text{ }^\circ\text{C}$ | - | - | 11 | A |
| Diode pulse current ²⁾ | $I_{S,pulse}$ | | - | - | 28 | |
| Diode forward voltage | V_{SD} | $V_{GS}=0\text{ V}$, $I_F=11\text{ A}$, $T_j=25\text{ }^\circ\text{C}$ | - | 1.0 | 1.2 | V |
| Reverse recovery time | t_{rr} | $V_R=480\text{ V}$, $I_F=I_S$, $di_F/dt=100\text{ A}/\mu\text{s}$ | - | 140 | - | ns |
| Reverse recovery charge | Q_{rr} | | - | 0.7 | - | μC |
| Peak reverse recovery current | I_{rm} | | - | 11 | - | A |

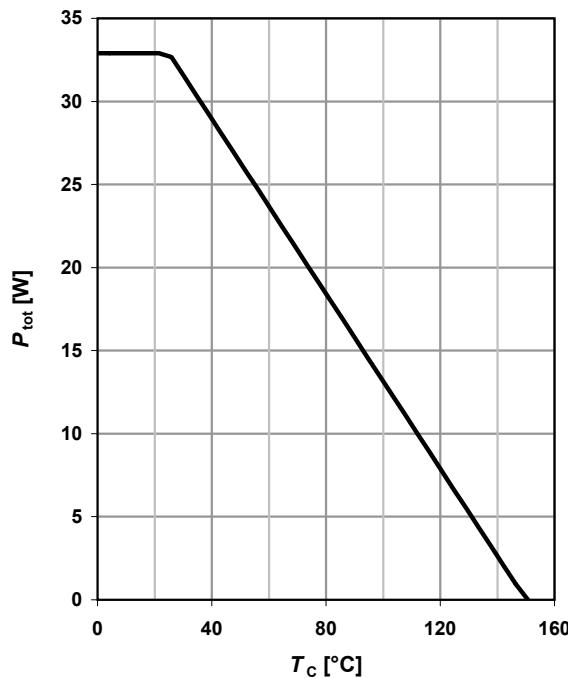
Typical Transient Thermal Characteristics

| Symbol | Value | Unit | Symbol | Value | Unit |
|-----------|--------|------|-----------|-----------|------|
| | | | | | |
| R_{th1} | 0.0178 | K/W | C_{th1} | 0.0000989 | Ws/K |
| R_{th2} | 0.0931 | | C_{th2} | 0.000939 | |
| R_{th3} | 0.228 | | C_{th3} | 0.00303 | |
| R_{th4} | 0.559 | | C_{th4} | 0.0245 | |
| R_{th5} | 1.58 | | C_{th5} | 0.951 | |
| | | | | | |



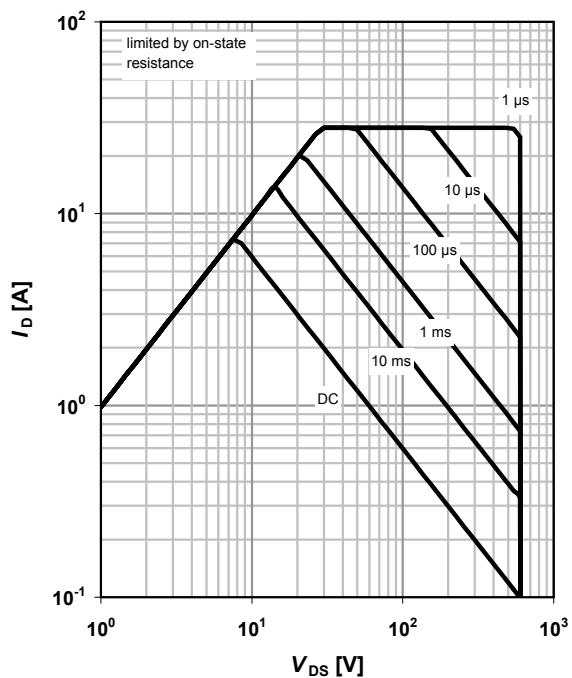
1 Power dissipation

$$P_{\text{tot}} = f(T_c)$$


2 Safe operating area

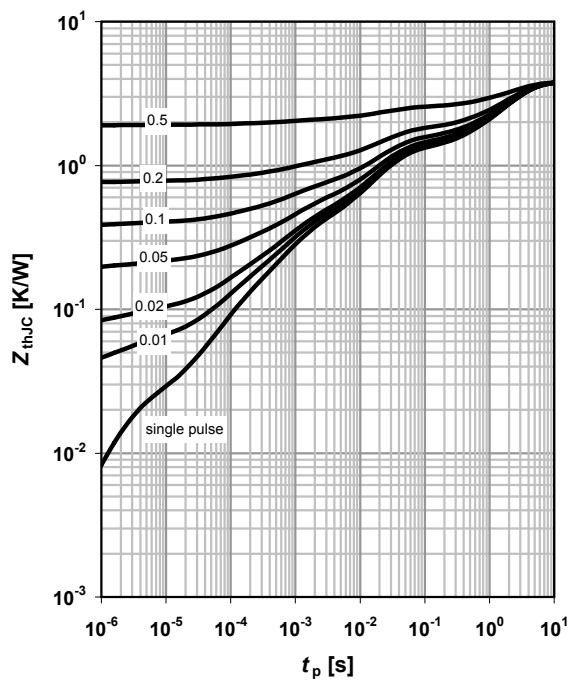
$$I_D = f(V_{DS}); T_c = 25^\circ\text{C}; D = 0$$

parameter: t_p


3 Max. transient thermal impedance

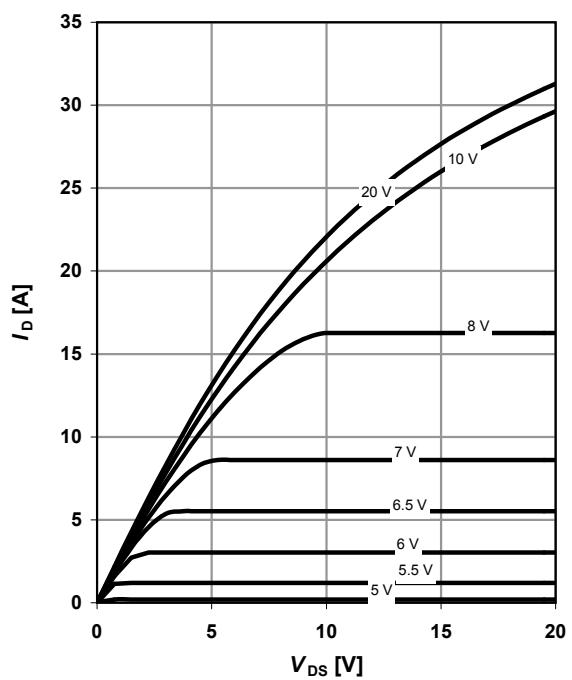
$$I_D = f(V_{DS}); T_j = 25^\circ\text{C}$$

parameter: $D = t_p/T$

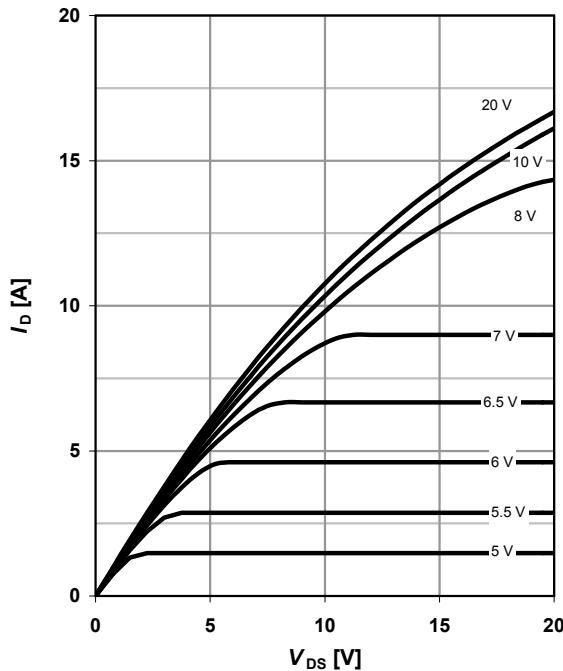

4 Typ. output characteristics

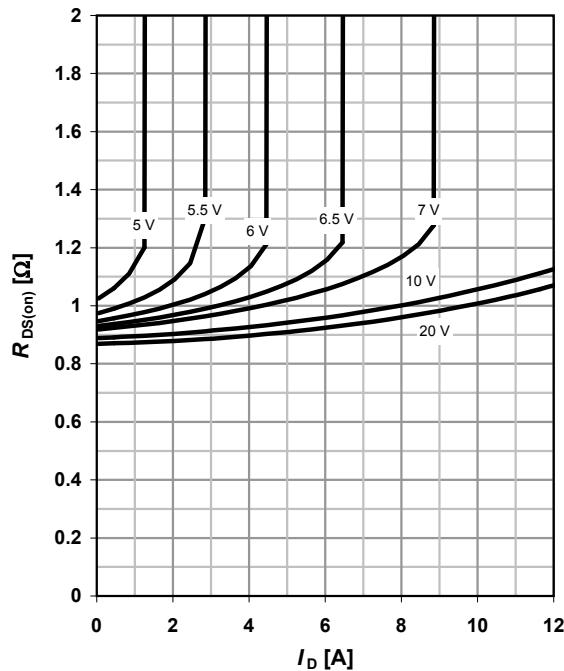
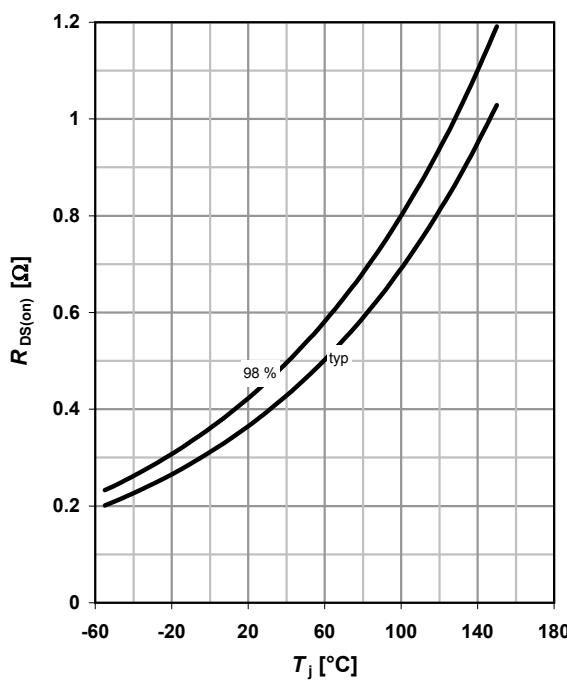
$$I_D = f(V_{DS}); T_j = 25^\circ\text{C}$$

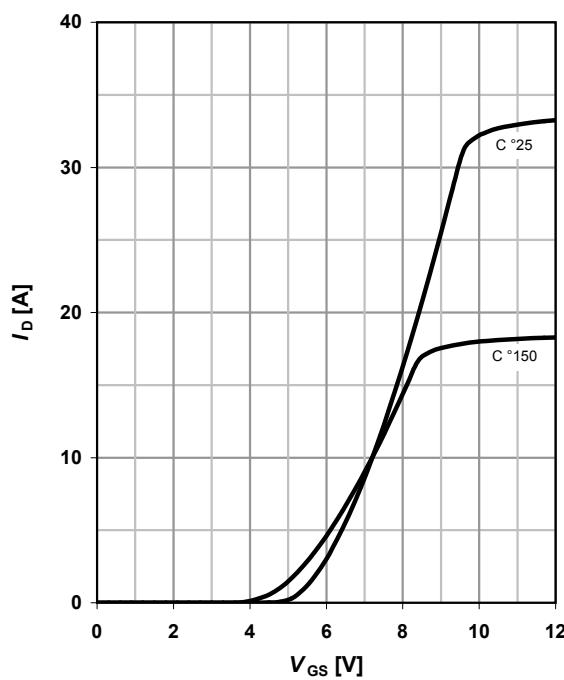
parameter: $t_p = 10\mu\text{s}$ V_{GS}



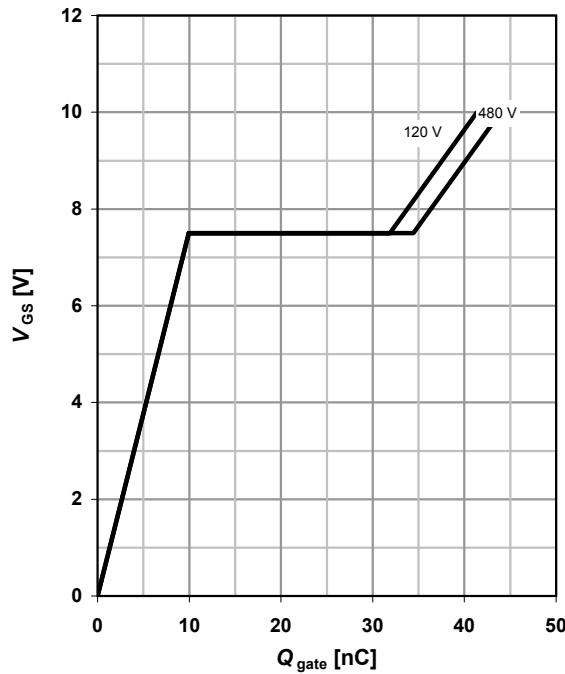
5 Typ. output characteristics
 $I_D = f(V_{DS})$; $T_j = 150 \text{ }^\circ\text{C}$

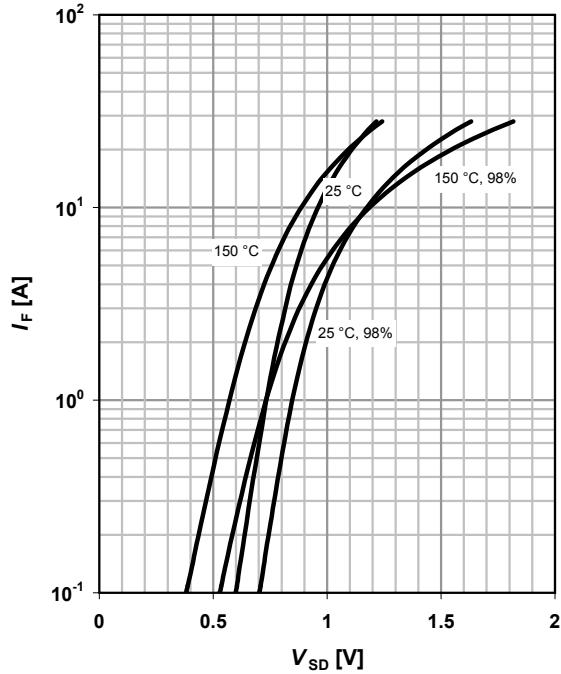
parameter: $t_p = 10 \mu\text{s}$ V_{GS}

6 Typ. drain-source on-state resistance
 $R_{DS(on)} = f(I_D)$; $T_j = 150 \text{ }^\circ\text{C}$

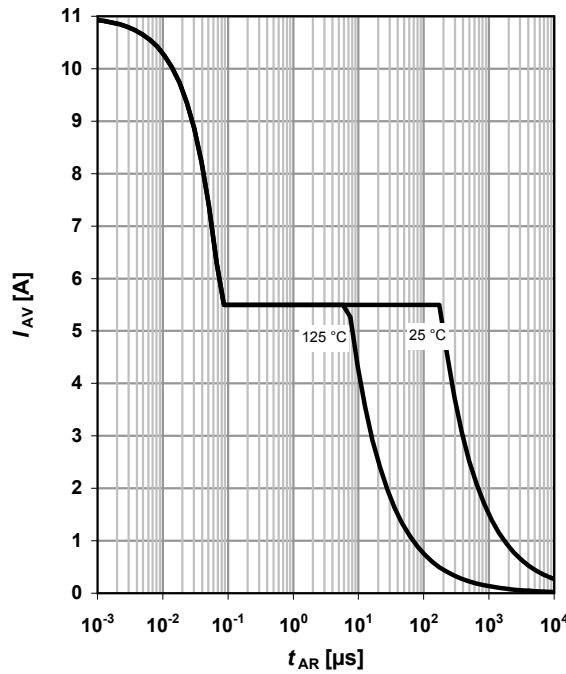
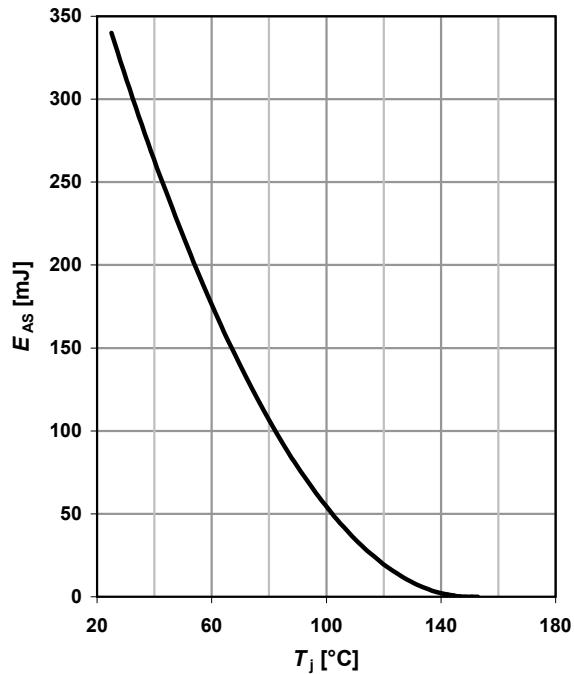
parameter: V_{GS}

7 Drain-source on-state resistance
 $R_{DS(on)} = f(T_j)$; $I_D = 7 \text{ A}$; $V_{GS} = 10 \text{ V}$

8 Typ. transfer characteristics
 $I_D = f(V_{GS})$; $|V_{DS}| > 2|I_D|R_{DS(on)max}$

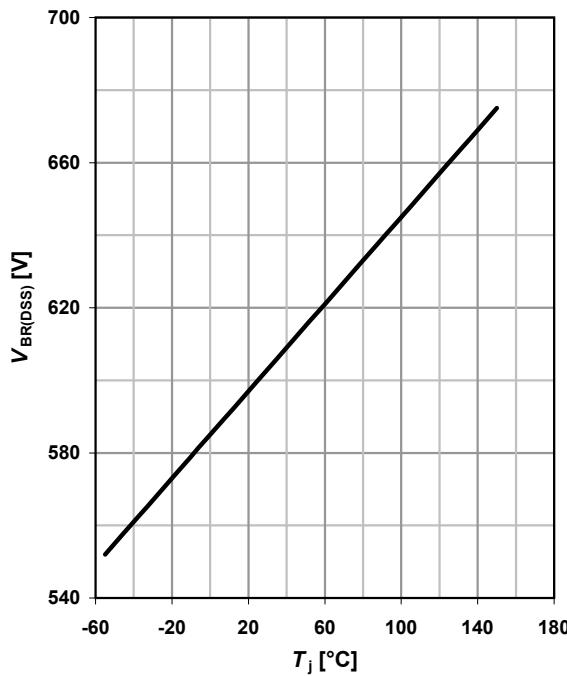
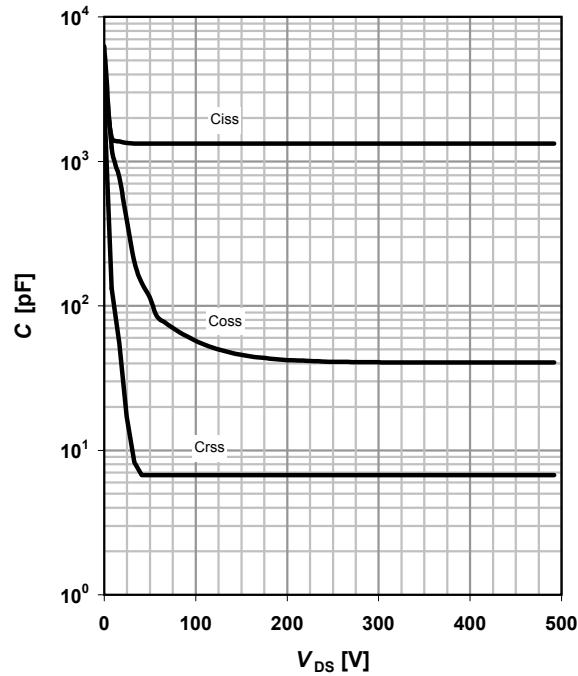
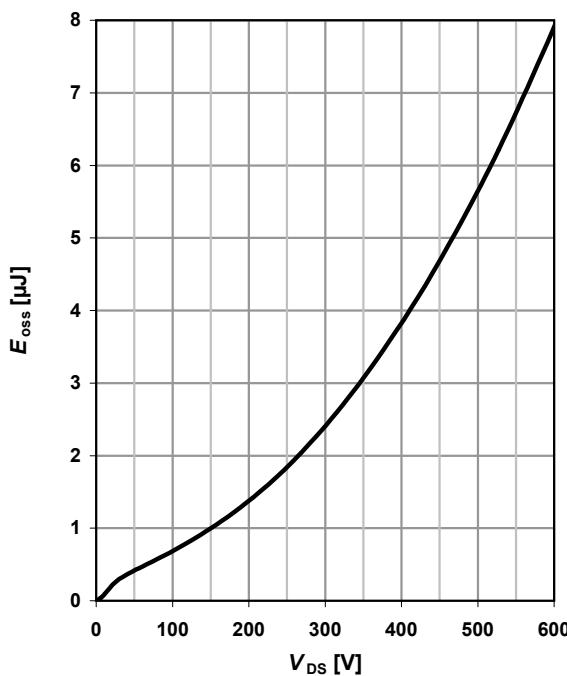
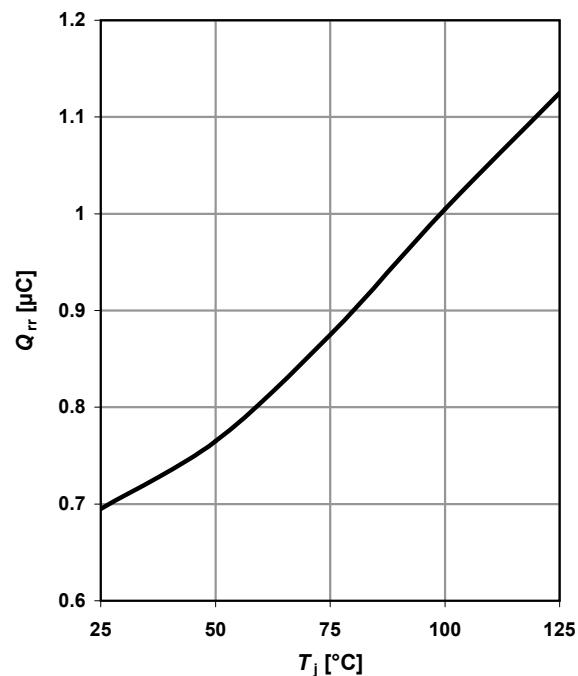
parameter: T_j


9 Typ. gate charge
 $V_{GS} = f(Q_{gate})$; $I_D = 11 \text{ A}$ pulsed

parameter: V_{DD}

10 Forward characteristics of reverse diode
 $I_F = f(V_{SD})$

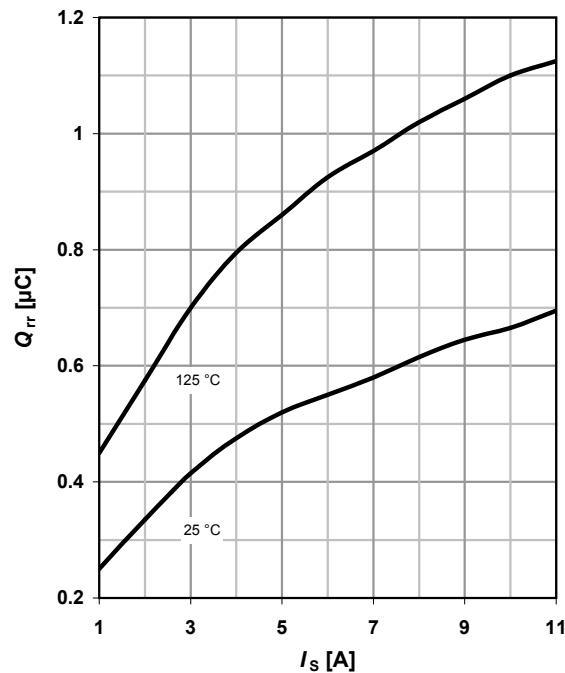
parameter: T_j

11 Avalanche SOA
 $I_{AR} = f(t_{AR})$

parameter: $T_{j(\text{start})}$

12 Avalanche energy
 $E_{AS} = f(T_j)$; $I_D = 5.5 \text{ A}$; $V_{DD} = 50 \text{ V}$


13 Drain-source breakdown voltage
 $V_{BR(DSS)} = f(T_j); I_D = 10 \text{ mA}$

14 Typ. capacitances
 $C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

15 Typ. C_{oss} stored energy
 $E_{oss} = f(V_{DS})$

16 Typ. reverse recovery charge
 $Q_{rr} = f(T_j); \text{parameter: } I_D = 11 \text{ A}$


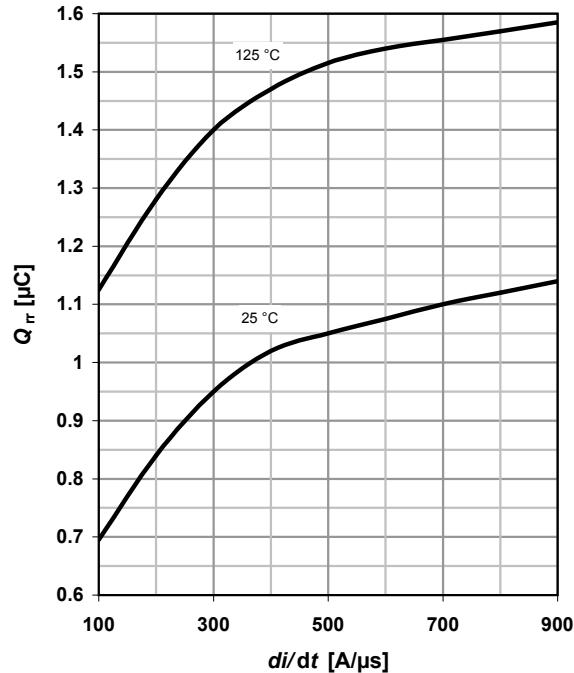
17 Typ. reverse recovery charge

$Q_{rr} = f(I_s)$; parameter: $di/dt = 100 \text{ A}/\mu\text{s}$

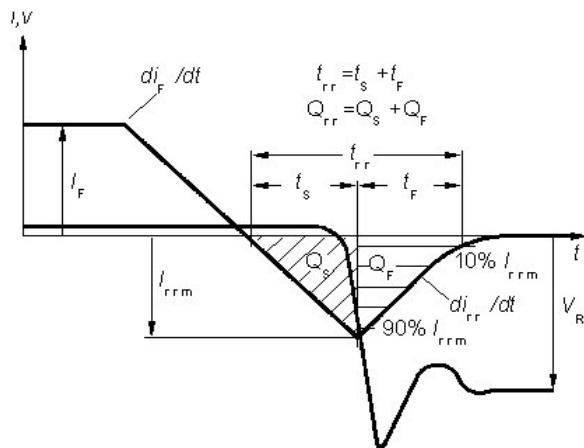


18 Typ. reverse recovery charge

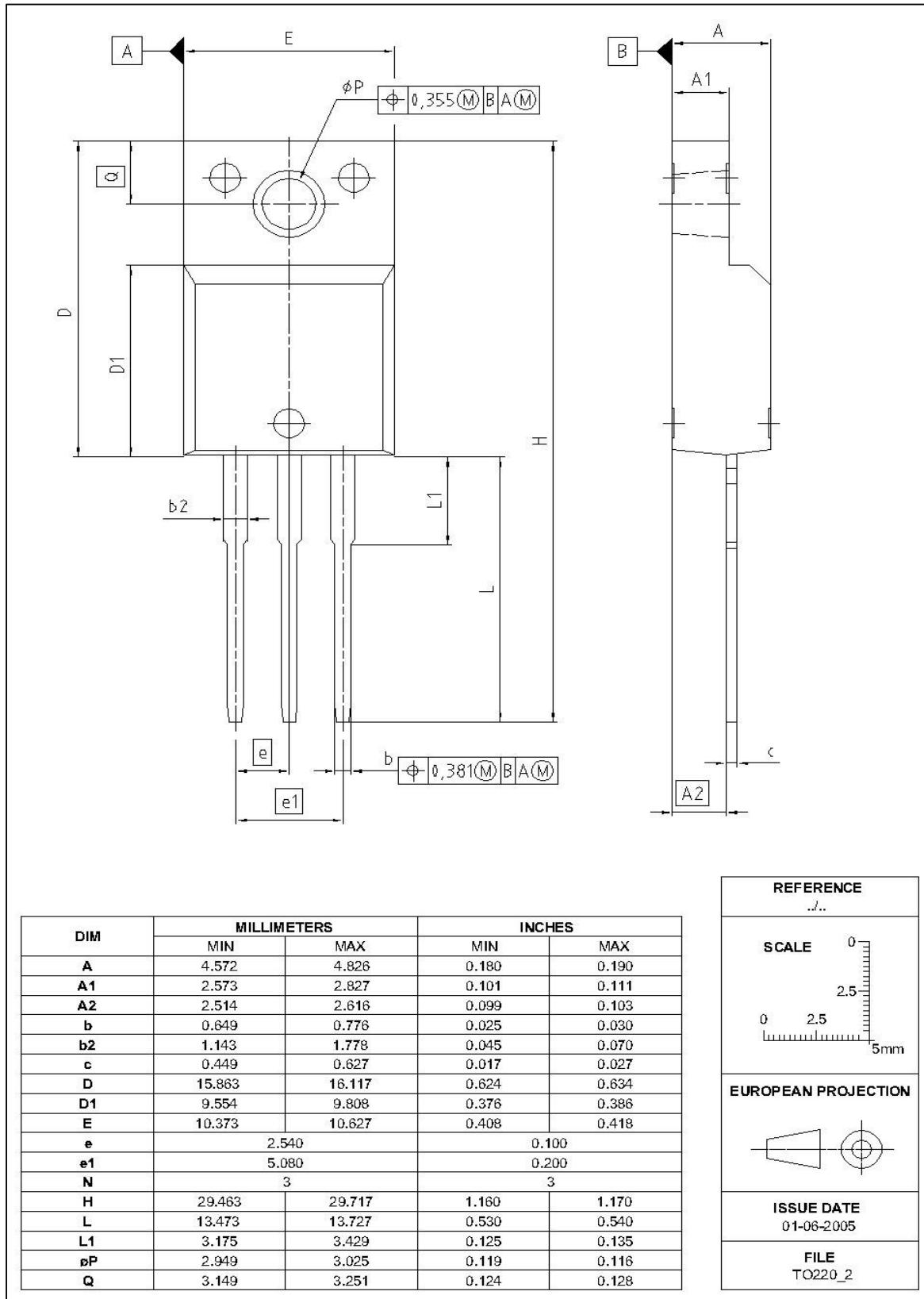
$Q_{rr} = f(di/dt)$; parameter: $I_D = 11 \text{ A}$



Definition of diode switching characteristics



PG-TO-220-3-31 (FullPAK)



Published by
Infineon Technologies AG
D-81726 München, Germany

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